

Blowing up the Balloon: Stoichiometry Using Baking Soda and Vinegar

Compounds that contain carbonate or bicarbonate ion react with acid to produce carbon dioxide gas and water. Baking soda consists of sodium bicarbonate (NaHCO_3).

The reaction of baking soda and vinegar is the reaction between sodium bicarbonate and acetic acid:



The Experiment:

Materials:

5 Erlenmeyer flasks (125 ml)	Marking pencil
5 balloons	Baking soda (NaHCO_3)
Piece of folded paper	Vinegar ($\text{HC}_2\text{H}_3\text{O}_2$)

1. Place 1.7 g of baking soda into each balloon. Use a piece of folded paper to help transfer the baking soda into the balloons.
2. Label the flasks 1, 4, 7, 10, and 15.
3. Place 3 ml of vinegar into the flask labeled “1”, 12 ml of vinegar into the flask labeled “4”, 21 ml of vinegar into the flask labeled “7”, 30 ml of vinegar into the flask labeled “10,” and 45 ml of vinegar into the flask labeled “15.”
4. Place one of the balloons over the top of the container, creating a seal, **WITHOUT LETTING THE BAKING SODA FALL INTO THE CONTAINER.**
5. Turn the balloon over so that all the baking soda drops into the container. Shake or swirl the mixture. Wait until the reaction stops (bubbling stops). What happens to the balloon?
6. **DO NOT REMOVE THE BALLOON.**
7. Repeat step 5 with the other balloons and containers. Record the result for each: Take note of the size of each balloon (measure the circumference with string) and what the substance looks like in the bottom of each flask in the table on the next page.
8. Now, remove the balloons from flasks 7, 10, and 15. Put a pinch of baking soda into each flask. Do the contents of any of these flasks bubble? Record your observations in the table on the next page.

	Flask #1	Flask #4	Flask #7	Flask #10	Flask #15
Balloon size					
Appearance of flask contents					
Bubbling w/ extra NaHCO_3 ?					
Identity of flask contents					

Questions:

1. Did any of the balloons inflate? If so, by how much? (Show with sketches).
2. Is there a relationship between the volume of vinegar used and the volume of the balloon?
3. Is there a point at which more vinegar does not increase the size of the balloon?
4. Is there a limit to the quantity of gas that can be produced from 1.7 g of baking soda? Why or why not??
5. How many moles is 1.7 g of NaHCO_3 ?
6. What is the maximum number of moles of $\text{HC}_2\text{H}_3\text{O}_2$ that could react?
7. What is the maximum number of moles of CO_2 produced?
8. What is the exact identity of the contents at the bottom of each flask? (Hint: use your observations to steps 7 and 8 in the procedure, as well as the chemical equation for the reaction, to fill in the last row of the data table).
9. In each bottle, which reactant limited the volume of gas formed (meaning there was not enough of this reactant), i.e. which is the limiting reagent?

